6. ~~A system in accordance with Claim 4 wherein the ultra-smooth cylindrical surface is comprised of a~~ substantially ~~cylindrical sleeve substantially~~ surrounding the marine element where D is an effective outside ~~diameter of the cylindrical element, including the cylindrical sleeve.~~

REMARKS

Attorney respectfully submits that the above amendments to the application, when considered in conjunction with the remarks below place claims 2 – 6 in a state ready for allowance. Attorney notes that the pagination referred to by the Examiner does not match the pagination of the application in Attorney's files. As such, the amendments set forth above and references to the specification below may not match the Examiner's copy of the application.

<u>Drawing Objections</u>

The Examiner sets forth objections Figures 8 and 14 in Paragraph 4 of the Office Action. Proposed red-lined changes are attached to this Response. Upon approval by the Examiner, corrected formal drawings will be submitted to the Draftsman.

<u>Claim Objections</u>

In Paragraph 5 of the Office Action, the Examiner objects to the use of terms "K/D ratio", in claims 2 and 3, and "K/D roughness parameter" in claims 5 and 6, requiring that only one of the terms be used. Attorney respectfully traverses the objection.

The specification utilizes both descriptions of the dimensionless parameter. *See*, page 7, lines 19 – 21 and page 8, lines 3 – 6. The patent statutes and case law require that claims need only "reasonably apprise those skilled in the art" as to their scope and be "as precise as the subject matter permits." *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1385 (Fed. Cir. 1986), *cert. denied*, 480 U.S. 947 (1987). Moreover, the applicants are allowed to act as their own lexicographer in the selection of claim language, provided that the language is clearly stated in the specification or prosecution history. *Kopykake Enters. v. Lucks Co.*, 264 F.3d 1377, 1381 (Fed. Cir. 2001).

The objected to language is clearly supported in the specification. Moreover, it clearly apprises those skilled in the arts as to the nature of the invention. Accordingly, amendment of the claims to select one of the phrases to the exclusion of the other is not required.

Rejection of Claims 1- 6 Under 35 U.S.C. §112, ¶2

In Paragraphs 6 – 8 of the Office Action, the Examiner rejects claims 1-6 under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter the applicant regards as the invention.

Attorney has amended claims 1 and 4 to particularly claim a K/D ratio or K/D roughness parameter of 1.0×10^{-4} or less, thereby clearly defining what is meant by ultra-smooth. Moreover, the definitions for K and D have been amended to specify an average measured surface peak to trough distance and an effective outside diameter of the cylindrical element to address the lack of proper antecedent. Attorney has fully addressed this basis for rejection.

Rejection of Claims 1, 3, 4 and 6 Under 35 U.S.C. §102(b)

In Paragraphs 9 – 10 of the Office Action, the Examiner rejects claims 1, 3, 4 and 6 as being clearly anticipated by Ortloff (U.S. Patent 4,398,487). It is stated that Ortloff discloses a substantially cylindrical fairing made of thermoplastic or aluminum or nickel alloys or plastic reinforced with fiberglass. It is argued that though Ortloff does not explicitly disclose or claim an ultra-smooth surface, the materials disclosed in the present application are similar to those disclosed in Ortloff '487 and that the fairing of Ortloff '487 must likewise have a K/D ratio of 5.1×10^{-4} or smaller. Attorney respectfully traverses the rejection.

Attorney first notes that Ortloff '487 discloses an elongated fairing 22 placed about a substantially cylindrical element 13. The present method and system claim a substantially cylindrical element, unlike Ortloff '487, which cannot be considered substantially cylindrical. Indeed, as noted in the specification at page 2, the present invention is intended to overcome the shortcomings of fairings such as Ortloff '487. Attorney respectfully submits that Ortloff '487 teaches at most a fairing system about a substantially cylindrical element to suppress VIV. As such, Ortloff '487 cannot anticipate the claimed invention.

Attorney also notes that the Examiner's reasoning for anticipation constitutes a logical fallacy known as "the False Analogy." In an analogy, two objects (or events), A and B are shown to be similar. Then it is argued that since A has property P, so also B must have property P. An analogy fails when the two objects, A and B, are different in a way that affects whether they both have property P. A clear explanation of this and other logical fallacies may be found at http://www.intrepidsoftware.com/fallacy/toc.htm.

The present invention and Ortloff '487 are not similar as discussed above.[1] Assuming, *arguendo*, that Ortloff '487 and the present invention are similar, there is nothing to suggest that Ortloff '487, in using the same materials, such as thermoplastic, has the ultra-smooth property. Merely disclosing the same material does not

[1] The present invention addresses VIV suppression of a cylindrical element by providing the cylindrical element with an ultra-smooth cylinder. Ortloff addresses VIV suppression of a cylindrical element by placing a fairing about it.

constitute a teaching of a K/D ratio of 1.0 X 10^{-4} or less. This ignores the reality that chemically identical materials may possess differing physical, structural or surface characteristics. To suggest that something may be made of carbon and that other carbon items possess the same characteristics ignores the differences in diamonds, graphite and buckyballs. Moreover, chemically identical materials may be processed in differing manners to result in differing physical, structural or surface characteristics. It is well known in the materials arts that metal alloys having identical chemical compositions will have varying physical characteristics based on whether the alloy is cast, wrought, quenched, heat treated, etc. The same is true herein – the mere recitation of similar materials does not suggest that the materials are similar in all manners. Attorney respectfully suggests that it is specious to state that Ortloff '487 anticipates the present invention when Ortloff '487 (a) is directed to a differing device and (b) fails to teach, disclose or suggest the K/D ratios claimed herein. Accordingly, claims 1, 3, 4 and 6 are patentable over Ortloff '487.

Paragraph 11 of the Office Action rejects claims 1 – 6 as being anticipated by Gregory (U.S. Patent 4,470,722). It is stated that Gregory '722 teaches a cylindrical housing for use with a marine production facility that has an exterior coating of fiberglass or plastic. Examiner admits that Gregory '722 does not disclose an ultra-smooth surface, but argues that since it discloses similar materials, it must therefore have a K/D ratio similar to that claimed in the present invention. Attorney respectfully traverses the rejection.

Attorney notes that the Examiner refers to Ortloff '487 and a "'584" patent in her argument. Attorney respectfully submits that the combination of references in the rejection of the claims is an improper application of §102(b). Further, the Examiner fails to identify the '584 patent.

Gregory '722 specifically states that its synctatic foam and fiberglass coverings are for the purpose of protecting the columns against impact and abrasion. *See*, col. 4, lines 36 - 68. There is nothing in Gregory '722 that discloses any method of dealing with VIV suppression. The Gregory '722 disclosure of the use plastic or fiberglass does not mean that it has the recited K/D ratio range. As noted above, differences in processing and chemical make up can lead to significant differences in physical characteristics, including surface roughness. Moreover, the Examiner's reasons are yet another example of the False Analogy logical fallacy and fail for the very same reasons stated above. Gregory '722 does not achieve VIV suppression as a result of the provision of an ultra-smooth surface having the recited K/D ratio range as does the present invention. Accordingly, claims 1-6 are patentable over Gregory '722.

Rejection of Claims 1 – 6 Under 35 U.S.C. §103(a)

In Paragraphs 12 and 13 of the Office Action, the Examiner rejects claims 1 – 6 as obvious over Blevins (U.S. Patent 6,206,614 B1) in view of the Mech 441, *Losses In Piping*, CE/ME 101 abc handout #5, *Incompressible Flow over Circular Cylinder* (CE/ME 101), or *Drag of Blunt Bodies and Streamlined Bodies*,

or *Transition Prediction in Flow over Roughness Elements*, or the email dated August 20, 2001 from Professor Smits of Princeton University. It is argued that Blevins teaches a substantially cylindrical sleeve and a method for controlling VIV based on relative position. It is admitted that Blevins does not teach an ultra-smooth surface. The Examiner takes notice that a smooth surface in a fluid creates less turbulent than rough surfaces. It is argued that at a given Reynolds number, the friction factor increases as the relative roughness increases. From this, the argument is made that it would have been obvious to one of ordinary skill in the art to include smooth surfaces to minimize drag and friction over the surface in accordance with the laws of fluid dynamics. Attorney respectfully traverses the rejection.

Blevins '614 teaches VIV suppression as a function of (a) the diameter of the columns, and (b) spacing of trailing columns. As noted in column 4, lines 5 – 30, a spacing of approximately 4 diameters is necessary for formation of vortices for cylindrical bodies having a high Reynolds number. Blevins teaches that by spacing the columns at something less than this number does not permit large vortices to form. VIV effects are minimized as a function of column diameter, column spacing, and expected current velocity. An example of how the spacing of columns, as disclosed in Blevins, affects vortex shedding and VIV may be found at: http://www.city.ac.uk/hydraulics/CFD/animjava.html, with reference to two cylinders and 3D and 7D spacing between the cylinders.

The present method and system are directed to suppression of VIV about a single element. There is no second column to break up vortex formation by providing insufficient space for vortex formation, as taught in Blevins. Claims 1 and 4 address a method and system for VIV suppression related to a cylindrical element – not (a) based on diameter and (b) spacing of multiple cylindrical elements.

The Examiner then relies on a number of different references to reach the conclusion that a smoother surface reduces drag and turbulent flow. Drag is a force exerted on the body as a result of the fluid flow. As noted in *Drag of Blunt Bodies and Streamlined Bodies*, Fig. 2, the drag coefficient for a cylindrical body is a function not only of the smoothness of the body, but the Reynolds number for that body. The drag coefficient is displayed in Fig. 2 over a large range of Reynolds numbers for a sphere and cylinder, with points in Fig. 2 corresponding to flow patterns in Fig. 3. Fig. 3(c) best illustrates the flow regime known as vortex shedding, described by Professor Smits as "energetic eddies" that dissipate mechanical energy and increase drag. *See*, http://www.princeton.edu/~asmits/Bicycle_web/bicycle_aero.html#intro. The Examiner is correct that a smoother surface can reduce drag for the cylindrical body in a fluid flow. As noted in *Drag of Blunt Bodies and Streamlined Bodies*, drag continues to exert a force on the body over the entire flow regime and Reynolds number range. *See*, Figs. 1 and 2.

VIV, while related to drag, is a different problem. VIV occurs in that flow regime where vortex shedding occurs. The vortex shedding frequency relationship is known:

$$f_s = \frac{S_t V}{D}$$

where V is the velocity of the fluid, D the diameter of the object and S_t is the Strouhal proportionality constant. The Strouhal number varies with Reynolds number, surface roughness and other factors but is generally in the range of .20 - .21. *See, Vortex Shedding Behind a Circular Cylinder* at 1.[2] The fluid boundary layer separates from the cylinder surface to form a free shear layer that is highly unstable. This shear layer will eventually roll into a discrete vortex and detach from the surface (hence, vortex shedding). Another type of flow instability emerges as the shear layer vortices shed from both the top and bottom surfaces interact with one another. They shed from the cylinder and generate a regular, alternating vortex pattern (the Karaman vortex street) in the wake. *See*, http://www.eng.fsu.edu/~shih/succeed/cylinder/cylinder.htm - Vortex-Induced Vibrations When vortices shed from the cylinder, uneven pressure distribution develops between the upper and lower surfaces of the cylinder, generating an oscillatory aerodynamic loading (lift) on the cylinder. This unsteady force can induce significant erratic vibrations on a structure. This effect is even more pronounced when the vortex shedding frequency approaches the natural frequency of the body. *Id.* Where the natural frequency (or some mode of the natural frequency) is approached, the cylindrical body may synchronize or "lock-in" with the Karaman vortex street. Where such lock-in occurs, the combined drag and VIV forces will cause the cylindrical body to undergo a figure 8 vibration in the fluid flow. VIV loading, locked-in or not, can induce fatigue stresses in a body that can ultimately cause the body to fail. Having addressed this, it can be appreciated that drag, while a component of fluid forces, differs from VIV.

The Examiner states that Mech 441 discloses a relative roughness parameter and relates it, together with the Reynolds number to a friction factor *f* (as opposed to frequency). It is then stated that the friction factor increases as surface roughness increases. From this, it is argued that while Mech 441 is directed to flow in a pipe, CE/ME 101 abc handout #5, *Incompressible Flow over Circular Cylinder* (CE/ME 101), or *Drag of Blunt Bodies and Streamlined Bodies*, or *Transition Prediction in Flow over Roughness Elements* all teach that relative roughness increases turbulent flow and drag over cylinders. It is argued that it would have been obvious of one of ordinary skill in the art to modify Blevins '614 to a smooth surface configuration by means of sleeves or coatings.

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[2] It will be appreciated that, relatively constant flow velocity, the shedding frequency decreases with diameter size. However, as the diameter increases, the Reynolds number for the body increases according to the formula:

$$\mathrm{Re} = \frac{VD}{\nu}$$

where V is the velocity of the fluid, D is the diameter of the body, and v is the kinematic viscosity. *See*, Mech 441 at 2. Again the velocity of the fluid (currents) and the kinematic viscosity of the fluid (sea water) may vary within certain ranges, but it is the selection of the diameter that dominates the determination of the Reynolds number.

As noted above, Blevins '614 addresses VIV as a function of column diameter and spacing – not surface smoothness. It is simply one other means of dealing with VIV, e.g. fairings, perforated shrouds, strakes. There is nothing in Mech 441 or CE/ME 101 abc handout #5, *Incompressible Flow over Circular Cylinder* (CE/ME 101), or *Drag of Blunt Bodies and Streamlined Bodies*, or *Transition Prediction in Flow over Roughness Elements* which suggests that smooth surfaces may be used to address VIV suppression. All address the issue of surface roughness and relation to **drag** – none address how smooth surfaces may be used to suppress VIV. As such the combined teachings of Blevins and the above references do not disclose, teach or suggest the application of a smooth surface in the claimed ranges to a cylindrical body for the purposes of VIV suppression.

Indeed, the only reference that does discuss surface smoothness and VIV cited by the Examiner is *Vortex Shedding Behind a Circular Cylinder*. Therein, a .4m cylinder was initially modeled with a surface roughness of 5 cm, i.e., a K/D ratio of 1.25 E-2, it was noted that the results were still unsatisfactory as vortex shedding still occurred. This means that the cylinder still underwent VIV. It was also noted that surface roughness was decreased to .001 mm, resulting in a K/D of 2.5 E-5. However, this second K/D ratio was modeled where velocity flow was zero, i.e., **no flow and no possibility of drag or VIV occurring**. *Id.* at 1. This is simply does not occur in the deepwater environment as bodies are subjected to a non-zero current flow. Even at low flow velocities, and a Reynolds number of 150,000, the paper teaches that vortex shedding occurs, which means VIV occurs. The claimed invention teaches a K/D range that is effective at suppressing VIV for cylinders having relatively large Reynolds numbers on the order of 2 E5 to over 1.5 E6, contrary to what was previously known. Page 7, lines 15 – 17.

The claims 1 and 4 teach a method and system for controlling drag and VIV suppression as a function of surface smoothness, whether integral to the body, as a sleeve or as a coating. Blevins '614 utilizes a totally different means of addressing VIV. The other references teach smoothness as a means of addressing drag and turbulence. The only reference that discusses smoothness and its effect on VIV teaches away from what is claimed in claims 1 and 4. As such, claims 1 and 4 are allowable over the cited art. Since claims 2 and 3 and 5 and 6 depend from claims 1 and 4 respectively and include each and every limitation therein, they are likewise patentable over the cited art.

Conclusion

Attorney notes the art made of record but not cited by the Examiner and declines to comment on same until such time as it is applied to the claims.

Attorney has addressed each objection and ground for rejection set forth in the Office Action. As such, Attorney believes that the present application is now in a state ready for allowance. In the event the Examiner has

any questions regarding the application, the amendments or remarks made herein, the Examiner is invited to call the undersigned at the telephone number listed below prior to the issuance of any formal action.

Respectfully submitted,
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Attachment: Drawings – Figures 8 and 14

APPENDIX A

In the Abstract

Please amend the abstract to read as follows:

A method [is disclosed] for controlling drag and vortex induced vibration in a substantially cylindrical element by providing an ultra-smooth surface about the cylindrical element. [A] The system [is also disclosed] for controlling drag and vortex induced vibration [in which] utilizes a substantially cylindrical marine element [has] having an ultra-smooth effective surface.

In the Specification

Please amend the paragraph beginning at Page 4, line 2 to read as follows:

FIGS. 1 and 2 illustrate a substantially cylindrical sleeve 10 presenting an ultra-smooth surface 12. Here the sleeve is a clam-shell design formed of fiberglass with a gel-coat presenting ultra-smooth surface 12. Opposing sides of the clam-shell are secured with hinges 14 and connectors such as latches 16 which may be secured with a hairpin 18 in one embodiment of the present invention. See also FIG. 3-4. In FIG. 5, a hinge 16 is shown as secured by pin 18 and retaining ring 19. Lifting provisions may be conveniently provided with lifting eyes 22. Ribs 20 provide some strength to the sleeve 10 and may be formed to axially secure the sleeve about riser sections.

Please amend the paragraph beginning at Page 5, line 2 to read as follows:

FIGS 12-13 illustrate another embodiment, here for using half length sleeve sections 10 with full length buoyancy modules 26. In this instance two types of sleeve sections are used, hanging sleeve 10A and stacking sleeve 10B. The hanging sleeve engages to the top surface of the buoyancy module and any centralizer presented there. [Whereas t]The stacking sleeve 10B can be configured to engage to the bottom of hanging sleeve 10A or to rest on top of the next lower hanging sleeve 10C and the ribs are configured accordingly. See FIG. 13.

Please amend the paragraph beginning at Page 6, line 5 to read as follows:

If sleeves are used to present the substantially cylindrical ultra-smooth surface, there are a number of alternatives to construct and attach[ed] or install the sleeves. For instance, the sleeve can be clam-shelled around the cylindrical element using hinges and alternative latching mechanisms such as snaps, bolts, or other fasteners. Alternatively, the sleeves can be made with a continuous circumference and slid over a cylindrical element. Or there are other alternatives for constructing a sleeve [form] from one or more sections. For instance, the sleeve need not be [constucted] constructed of halves, each covering an approximately equal amount of the circumference. A C sleeve (a sleeve that covers more than 180 degrees

of the circumference but less than 360 degrees of the circumference) can be made with the rest of the circumference optionally enclosed by a second piece that completes the circumference. The C shaped sleeve can be clam-shelled around the cylindrical element using hinges and a latching mechanism, or can be slid over the structure. Further, sleeves, or sleeve sections, covering all or part of the circumference, can be held in place using hardware that is attached to the cylindrical element itself. This hardware can include latches, receptacles for bolts, pins, rivets, screws, or other fasteners. Or, a sleeve that consists of two or more parts, which make up the circumference, can be made such that the parts are held together by straps or banding materials. This includes the possibility of providing grooves in the cylindrical element to allow for strapping materials. Further, the sleeves can be pre-installed , they can be installed on the cylindrical element during its installation (e.g. while running a drilling riser); or they can be installed after the cylindrical element has already been installed (a post-installation).

Please amend the paragraph beginning at Page 7, line 4 to read as follows:

While there are many ways to provide it, a critical aspect is the ultra-smooth surface. The drag coefficient for flow past a cylinder sharply decreases as the Reynolds number is increased beyond about 200,000 (called the "critical" Reynolds number range) and then slowly recovers (called the "supercritical" Reynolds number range). While it was recognized that [and] surface roughness can [e]<u>a</u>ffect the Reynolds number at which this "dip" occurs and can add to the drag coefficient, conventional wisdom held that cylindrical elements should experience[d] substantial VIV accompanied by fairly large drag at critical and supercritical Reynolds number ranges.

Pleas amend the paragraph beginning at Page 7, line 13 to read as follows:

But, surprisingly, it was discovered that a very smooth cylinder would not experience VIV in this Reynolds number range, and furthermore this cylinder would experience very low drag. Further, [the] an "ultra-smooth" sleeve can be effective in Reynolds number ranges from about 200,000 to over 1,500,000, perhaps more. In fact, benefits begin to be seen in the VIV and drag at a Reynolds number of about 100,000.

Please amend the paragraph beginning at Page 7, line 22 to read as follows:

K is the <u>roughness density and is the</u> average peak to trough distance of the surface roughness (e.g., as measured using confocal scanning with an electron microscope); and D is the effective outside diameter of the cylinder element, including any sleeve or coating.

Please amend the paragraph beginning at Page 8, line 3 to read as follows:

Substantial reduction in VIV can be observed where K/D is less than about 1.0×10^{-4} and is most pronounced at about 1.0×10^{-5} or less for fairly uniform roughness densities. [A higher K/D ratio may allow achieving the same] Similar results may be achieved where the roughness density decreases, even though the overall K/D ratio may increase.

Please amend claims 1 – to read as follows:

1. (First Amended) A method of controlling drag and vortex induced vibration in a substantially cylindrical element comprising providing an ultra-smooth surface about the cylindrical element having a K/D ratio of 1.0×10^{-4} or less where:

K is an average measured surface peak to trough distance; and

D is an effective outside diameter of the cylindrical element.

2. (First Amended) [A] The method of controlling drag and vortex induced vibration in accordance with Claim 1, wherein providing the ultra-smooth surface comprises providing a coating about the cylindrical element [having a K/D ratio of about 1.0×10^{-4} or less] where D is an effective outside diameter of the cylindrical element, including the coating[:

K is the an average peak to trough distance; and

D is the effective outside diameter of the cylindrical element, including the coating.

3. (First Amended) [A] The method of controlling drag and vortex induced vibration in accordance with Claim 1 wherein providing the ultra-smooth surface comprises providing a substantially cylindrical sleeve about the cylindrical element [having a K/D ratio of about 1.0×10^{-4} or less] where D is an effective outside diameter of the cylindrical element, including the sleeve[:

K is the average peak to trough distance; and

D is the effective outside diameter of the cylindrical element, including the sleeve].

4. (First Amended) A system for controlling drag and vortex induced vibration, comprising:

a substantially cylindrical marine element[; and] having

an ultra-smooth effective surface [about the substantially cylindrical marine element] with a K/D roughness parameter of about 1.0×10^{-4} or less, where:

K is an average measured surface peak to trough distance; and

D is an effective outside diameter of the cylindrical element.

5. (First Amended) A system in accordance with Claim 4 wherein the ultra-smooth cylindrical surface is comprised of a coating material [having a K/D roughness parameter of about 1.0 X 10^{-4} or less] where D is an effective outside diameter of the cylindrical element including the coating[:

K is the average peak to trough distance; and

D is the effective outside diameter of the cylindrical element, including the coating].

6. (First Amended) A system in accordance with Claim 4 wherein the ultra-smooth cylindrical surface is comprised of a substantially cylindrical sleeve substantially surrounding the marine element [having an outside K/D roughness parameter of about 1.0 X 10^{-4} or less] where D is an effective outside diameter of the cylindrical element, including the cylindrical sleeve [:

K is the average peak to trough distance; and

D is the effective outside diameter of the cylindrical element, including the sleeve].